



Earthquake Engineering Research Program Update

Quarterly Newsletter

June - September 1998

Vol. 1, No. 1

Corps of Engineers Earthshaking News



Corps EQEN Budget Cuts Hit Hard

The EQEN Program took a beating in the most recent round of budget cuts by the Civil Works R&D Committee. Our requested budget of \$3.7M was first reduced to \$2.65M and then in the latest round to \$2.15M. This level of funding significantly reduces our ability to show finished products this FY.

Don Dressler was successful in getting one EQEN new start approved, namely the proposed work unit on Retaining Walls, C-SLIP. However, the funding will be insufficient to start the special task on liquefaction of fine grained soils, as well as many other planned accomplishments.

Every work unit received a hard cut. The Special Studies work unit has been renamed as Program Management, and funding was cut by 70% from the level requested prior to the May 98 Field Review Group Meeting. Percentage cuts are shown in the following table.

Field Review Group Mentor(s)	Principal Investigator(s)	Work Unit	FY 99 Cuts (%)
Chudgar	Hynes	Program management	34
Hempen/ Griffiths	Krinitzsky/ Murphy	Geology/seismology	3
Hempen/ Griffiths	Yule	Ground motion analysis	22
Allen/Baer/ Chudgar	Koester	Penetration resistance	25
Hempen/Baer	Ballard	Geophysical investigation	3
Allen	Ledbetter/ Olsen	Behavior of liquefying soils	39
Forrest	Sharp	Failure mechanism and damage assessment	3
Decker	Dove	Intake towers	15
Chudgar	Woodson	Ductility of outlet works	19
Erickson	DeBejar	Subbottom absorption	14
Pizsker	DeBejar	Concrete dams	16
Chudgar	Ebeling/ Matheu	Nonlinear analysis of concrete dams	14
Walberg/ Chudgar	Ebeling	Retaining walls (CSLIP)	42
Walberg	Peters	Deformation analysis of embankment dams	16

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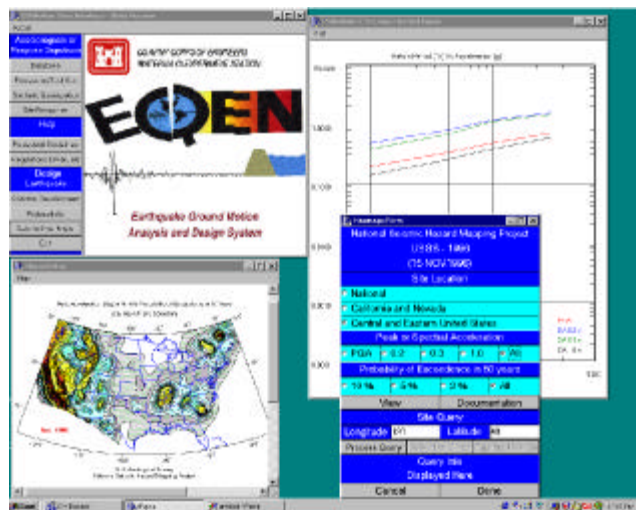
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Beta Ground Motion System Version Due Out in January 1999

Earthquake ground motion analysis software is currently being ported from UNIX to a Microsoft Windows environment, which will enable technology transfer to field users.



The current schedule is to distribute the system to Beta sites in January 1999. The initial version will have capabilities to:

- ! query an integrated strong motion catalog and accelerogram database;
- ! develop probabilistic equal hazard response spectra from NEHRP national seismic hazard maps by query; and
- ! develop site-specific spectra and peak parameters for ground motions based on tectonic environment, magnitude, intensity, and distance from source.

The system will also include a 1-D site response module and on-line ER 1110-2-1806. Additional objectives for this year are to continue work on the probabilistic seismic hazard calculation module, and include deterministic seismic hazard maps and response spectra development tools.

Centrifuge 98 Conference, Tokyo, Japan

Researchers from around the world met during the 23-25 September 1998 Centrifuge 98 Conference. Presentations concerned centrifuge facilities, equipment, and instrumentation for both static and dynamic problems, model preparation and in-flight characterization, earthquake and dynamic effects, shallow and deep foundations, excavations and retaining structures, geo-environmental problems, buried pipes and underground structures, tunnels, earth reinforcement and anchors, ground improvement, and cold region problems.

Four workshops were also conducted to allow for more in-depth presentations and discussions concerning underground construction, foundations, earthquake effects, dynamic problems, soil improvement, earth reinforcement, and anchors.

US-Japan Centrifuge Workshop

On behalf of Dr. Hynes, Chairman of the UJNR Liquefaction Committee, Mike Sharp led the U.S. Team and co-chaired a workshop on centrifuge testing to investigate liquefaction phenomena. The workshop was held at the Public Works Research Institute in Tsukuba, Japan, and consisted of 2 days of presentations and discussions by 9 U.S. and 30 Japanese participants. The U.S. team included Ricardo Dobry (RPI), Ryan Phillips (C-Core), Bruce Kutter (UC-Davis), Hon-Yim Ko (Univ. of Colorado-Boulder), Scott Steedman (GIBB), Richard Ledbetter (WES), Wipawi Vanadit-Ellis (WES), and Mike Sharp (WES). All attendees gave presentations and participated in fruitful discussions that raised several key points in centrifugal investigations. Discussions concerned the use of sinusoidal motions versus actual field recorded motions for research purposes, the variations and applications of different containers, the need for more numerical modeling and field validation, the need to extract more from recorded data than presently employed, and the need to share and cooperate more with other researchers.

In Situ Penetration Testing for Cyclic Strength: Liquefied Gravels in Alaska

The first penetration tests with energy measurements in gravelly soils known to have liquefied were performed under the direction of Dr. Joe Koester during August to investigate deposits affected by the 1964 Good Friday Earthquake in Seward, Alaska. Blowcount records from standard penetration tests (SPT's) in gravels are erratic and often too high using the standard-size split spoon and a 140-lb safety hammer (at left in Figure 1); recovery of soil is also inhibited in coarse-grained deposits. The larger penetrometer split spoon in the center of Figure 1 was driven at Seward using the 346-lb safety hammer to its right. Both of the solid conical probes shown at the bottom were driven as dynamic penetrometers for comparison to earlier tests at this site. Split spoon samples were shipped to WES for laboratory analysis.



Figure 1. Samplers



Figure 2. Measurement equipment

Dynamic energy measurement equipment was loaned for these tests by British Columbia Hydropower, as was the radar gun also shown in the center of Figure 2. The radar gun is pointed upward to measure the actual drop velocity of the safety hammer to support computation of kinetic energy for comparison to the force and acceleration measurements. Energy adjustment is required to allow comparison between SPT or other dynamic penetration tests conducted at different sites and to isolate variations in penetration resistance due to soil strength from those caused by differences between operators and equipment.

Crosshole shear wave velocity measurement will be performed in FY99 at this site to be correlated with penetration resistance.

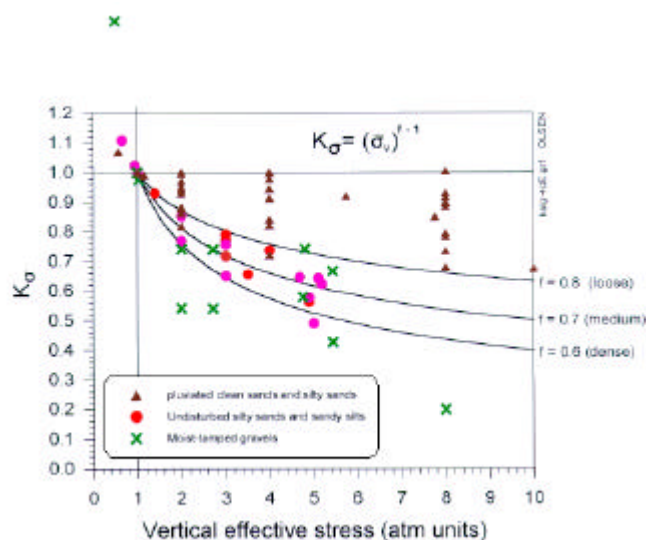
EQEN K_o Recommendations Adopted Internationally

Recommendations from the EQEN K_o research by Drs. Hynes and Olsen were adopted by the MCEER International Liquefaction Committee and the Panama Canal Commission Geotechnical Advisory Board this summer. This research on the liquefaction confining stress factor K_o resolved the controversy between low estimates of K_o from U.S. researchers and high estimates of K_o from Canadian researchers. Overestimation of K_o can be unsafe and underestimation can result in unnecessary remediation expenditures. Drs. Hynes and Olsen built and analyzed a large database from published K_o laboratory data and concluded:

- 1) K_o is strongly influenced by method of deposition, stress history, aging effects, and density;
- 2) K_o is not strongly influenced by soil type ranging from silts to gravels;
- 3) Reconstructed, pluviated specimens in the laboratory may represent recently deposited dredged materials or recently liquefied materials; however,
- 4) High quality undisturbed samples are needed to determine field-relevant values of K_o .

EQEN K_σ Recommendations Adopted Internationally, from page 3

In 1984 Dr. Olsen published the following recommendation: $K_\sigma = (\sigma'_v)^{f-1}$, with $f = 0.7$ for sands. The EQEN research confirmed and extended this approach with $f = 0.8$ for loose soils, $f = 0.7$ for medium dense soils, and $f = 0.6$ for dense or overconsolidated soils. The larger the exponent f , the larger the value of K_σ . Stress history, aging, and increased density result in lower values of f and, consequently, lower values of K_σ , as shown in the figure below with the data points.



The Panama Canal Commission Geotechnical Advisory Board adopted these conclusions and recommendations for the ongoing seismic safety evaluation of Gatun Dam on 15 July 1998 in Panama City, Panama. The MCEER International Liquefaction Committee adopted these conclusions and recommendations for K_σ on 14 August 1998 in Salt Lake City. The distinguished members of these groups are:

Panama Canal Commission Geotechnical Advisory Board:

Norbert Morgenstern, Univ. of Alberta
James Michael Duncan, VPI
William F. Marcuson III, WES
Robert Wesson, USGS at Golden, CO

MCEER International Liquefaction Committee:

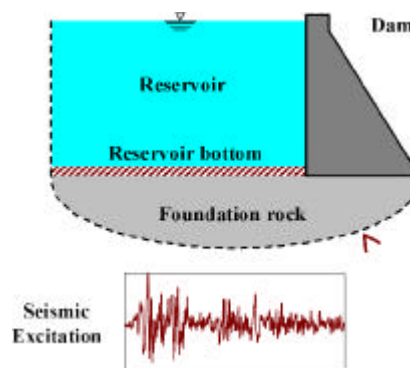
James K. Mitchell, VPI
Ricardo Dobry, RPI
Les Harder, CA Dept of Water Resources
Izzat Idriss, Univ. of California-Davis
Raymond B. Seed, Univ. of Calif. Berkeley
Liam Finn, Univ. of British Columbia, Vancouver
Les Youd, Brigham Young Univ.
Gonzalo Castro, GEI
Ken Stokoe, Univ. of Texas, Austin
Peter Robertson, Univ. of Alberta
Ron Andrus, NIST
Joseph Koester, WES
Mary Ellen Hynes, WES (author)

Nonlinear Response of Concrete Dams

Dr. Bob Ebeling (WES) and Dr. Enrique Matheu (VPI) are developing time-domain, computer-based analysis tools to predict the two- and three-dimensional nonlinear response of concrete dams subjected to seismic excitations. Two companion computer programs are being developed to accommodate different levels of modeling (two- and three-dimensional analyses). Computer models will account for effects of nonlinear material response of concrete, structure-reservoir and structure-foundation interactions, as well as

energy dissipating mechanisms associated with an absorptive reservoir bottom.

The computer platform serving as the basis for the two-dimensional analysis tool is complete. This PC-based computer



Nonlinear Problems of Concrete Dams, from page 4

program has a modular structure equipped with several alternative analysis options for static, eigenvalue, and dynamic problems. Different formulations are user-selectable to specify mass and damping characteristics of the system. Dynamic analysis is performed in the time domain, using a fully stable Newmark scheme. Linear or nonlinear material characteristics can be user-specified to describe the concrete constitutive behavior. In the nonlinear case, a smeared-crack model is implemented to capture the tensile cracking phenomenon.

Numerical simulations are currently being performed to validate the nonlinear material model and to calibrate some of its parameters, using results available in the literature. Finer tuning of this model will be achieved upon conclusion of shaking table experiments proposed in a companion work unit.

Intake Towers

Work is proceeding well in the intake tower work unit. The ultimate objectives of this experimental effort are the development and validation of simplified analysis procedures for the evaluation of the ductility of existing intake towers and the provision of design and retrofit guidance for intake towers. These objectives have been partially met by the results of past experimentation and analysis efforts. Models of typical existing towers have been shown to possess substantial ductility. A deflection-based analysis technique has also been shown to have considerable promise as a simplified analysis procedure for the evaluation of this ductility. However, intake towers are unusual structures, and several important questions must be answered before this procedure can be applied. An objective of the current experimental effort is to begin to answer these questions.

This year, 10 half-scale experimental models have been constructed. The reason for conducting these experiments is to determine

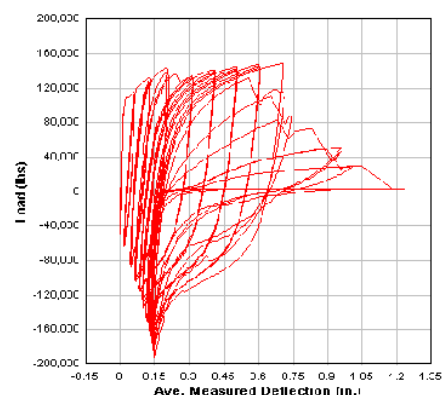
the strain penetration/failure deflection characteristics of reinforcing typical of existing intake towers. This



Figure 1. Load frame and experimental wall section model



Figure 2. Post-experiment condition of wall section model



will provide information on parameters required for the application of the deflection-based analysis technique and on the scaling of model experiments. Conducting 10 experiments allows for a full-factorial variation of three variables; steel strength, reinforcing bar diameter, and concrete strength. Each experiment consists of the vertical cyclic loading of a model tower wall section (Figure 1). Strains and deflections are measured up to failure of the specimen. To date, two experiments have been completed, with good results. The experimentation device functioned properly, and the 68 strain and deflection gages worked well (Figure 2). Significant ductility was exhibited by the models. This ductility can be seen in the load-deflection curve from the first experiment. After the initial elastic response, many cycles of plastic deflection were required before failure occurred (Figure 3). Further analysis, as well as completion of the remaining experiments is expected to contribute significantly to the development of the deflection-based analysis technique. The next step will be validation of the procedure with dynamic experimentation.

Calendar of Past Events

31 May - 4 June 1998 - Sixth U.S. National Conference on Earthquake Engineering (EERI), Seattle, WA - Dr. Krinitzsky organized the session in which Probabilistic and Deterministic Seismic Hazard Analysis Procedures were debated. A special publication is forthcoming.

10 - 11 July 1998 - PEER Workshop on Earthquake Risks to Transportation Systems, Stanford University, Palo Alto, CA - PEER is the new California-based NSF earthquake research center.

3 - 6 August 1998 - ASCE Specialty Conference on Geotechnical Earthquake Engineering and Soil Dynamics, University of Washington, Seattle, WA - Dr. Krinitzsky was an invited speaker to identify shortcomings of probabilistic seismic hazard analysis procedures. John Nickell (SPK) and Jeff Farrar (USBR) co-authored and presented an excellent paper on the effect of long rods on penetration resistance.

10-14 August 1998 - Eighteenth USCOLD Annual Meeting, Buffalo, NY - Excellent presentation by Art Walz and other Corps members.

14 - 15 August 1998 - MCEER International Liquefaction Committee Workshop on "Simplified Procedures for Liquefaction Potential Evaluation", Salt Lake City, UT - Drs. Mary Ellen Hynes and Joe Koester attended; purpose of workshop was to finalize procedural and technical issues raised during an original workshop of the same purpose held in 1996, in order to publish guidance for earthquake engineering practitioners. New information was presented for interpretation of cone penetration test (CPT) results for liquefaction susceptibility investigations and for the influence of confining stress on cyclic strength (*see EQEN K_o Recommendations article on page 3*). A paper representing the proceedings and follow-on revisions is in production on behalf of all participants for publication in the ASCE Journal of Geotechnical and Geoenvironmental Engineering.

10-11 September 1998 - "Workshop on the Physics and Mechanics of Liquefaction," in Baltimore, MD was hosted by the Johns Hopkins University and sponsored by the National Science Foundation - Richard Ledbetter and Joe Koester attended; workshop proceedings will be published by Balkema of Rotterdam, Netherlands in the coming months.


23-25 September 1998 - Centrifuge 98, Tokyo, Japan - Organized by the Japanese Geotechnical Society in collaboration with the Technical Committee TC2 on Centrifuge Testing of the International Society of Soil Mechanics and Geotechnical Engineering - Mike Sharp, Richard Ledbetter, and Wipawi VanAdit-Ellis attended; Mike Sharp (WES) presented a paper entitled "Cone penetration modeling in sand for evaluation of earthquake-induced lateral spreading," which was co-authored by Ricardo Dobry (RPI) and Ryan Phillips (RPI).

28-29 September 1998 - UJNR Panel on Wind and Seismic Effects Liquefaction Committee Workshop on Centrifuge Testing, Tokyo, Japan - *See article on page 2.*

11 - 15 October 1998 - Dam Safety '98: 15th Annual ASDSO Conference, Las Vegas, NV

News of Note

- ! **Dr. Mary Ellen Hynes** has been appointed to the USCOLD Earthquake Committee.
 - ! **Dr. Mary Ellen Hynes** has been named Editor for the ASTM Technical Journal.
 - ! **Dr. James May** has been installed as President of the Association of Engineering Geologists.
 - ! **Dr. Janet Simms** is President-Elect for the Near Surface Geophysics Section of the Society of Exploration Geophysicists.
 - ! **Mr. Keith Sjostrom** has been named Editor of the newsletter for the Near Surface Geophysics Section of the Society of Exploration Geophysicists.
 - ! **Ms. Maureen Corcoran** has been appointed to the State Review Board of the Mississippi Board for Geological Registration.
 - ! **Dr. Lillian Wakeley** was reappointed to the Committee on Basic Research for TRB.
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 Earthquake Engineering Research Program Update	
HQ Program Monitors Tony Liu (RD-C) Al Branch (CW-EG) Mike Klosterman (CW-EG) Lucian Guthrie (CW-ED) ❖ Program Manager Mary Hynes (WES-GG) <i>Geotechnical</i> Don Yule <i>Structures</i> Dr. Robert Hall	Field Review Group Members Matt Allen (SPK) Greg Baer (SAD) Anjana Chudgar (LRL) Ray Decker (NWD) Donald Erikson (NWP) Wayne Forrest (MVK) James Griffiths (NWP) Greg Hempen (MVS) JoAnn Piszker (SPL) Francke Walberg (NWK)
<i>Future articles to EQEN Update may be submitted via email to: graut@wes.army.mil.</i>	
Web address: geoscience.wes.army.mil	

SMIP Report Published

WES Technical Report GL-98-25 entitled "U.S. Army Corps of Engineers Seismic Strong-Motion Instrumentation Program" by Robert F. Ballard, Jr. and Tina H. Grau was published in September 1998. The purpose of this report was to present various aspects of the USACE SMIP including criteria for design of installations, recording equipment, operation, maintenance, performance to date, upgrades, future goals, and importance of interagency cooperation. Particular attention was focused on economics and advantages associated with ultimate conversion to remotely accessed digital instrumentation.

Copies of the report will be distributed to Corps' District and Division SMIP points of contact. Future plans are to make the report available in portable data format on the worldwide web.

Calendar of Future Events

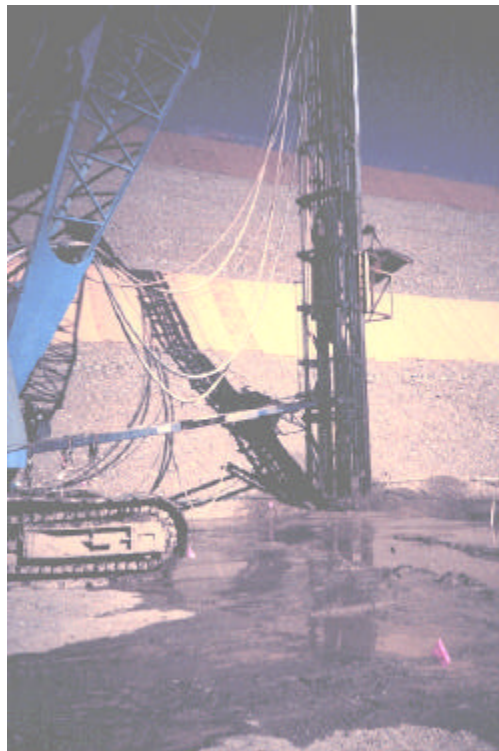
- 3 Nov 98 - EERI Earthquake Reconnaissance Training Workshop, St. Louis, MO
- 6 Nov 98 - USCOLD Earthquake Committee Meeting, East Side Reservoir Project, Hemet, CA
- 10 Nov 98 - EERI Earthquake Reconnaissance Training Workshop, Los Angeles, CA
- 19-20 Nov 98 - Earthquake Engineering of Concrete and Masonry Buildings: Short Course, Charlotte, NC
- 3 Dec 98 - UJNR Panel on Wind and Seismic Effects, U.S. Meeting, Gaithersburg, MD
- 7-8 Jan 99 - Mid-America Seismic Hazard Meeting and Workshop, Saint Louis University, St Louis, MO - Sponsored by USGS, Saint Louis University and MAE Center (Mid America Earthquake Center)
- 10 Jan 99 - TRB Workshop on New Approaches to Liquefaction Analysis, Washington, D.C.
- 28 Feb - 3 Mar 99 - MASC Seismic Risks and Solutions for Highways and Bridges in the Central and Eastern United States, St. Louis, MO
- Mar 99 - Corps' Dam Embankment Prioritization Workshop for Seismic Deficiencies, Vicksburg, MS
- May 99 - UJNR Annual Meeting, Panel on Wind and Seismic Effects, Tsukuba, Japan
- May 99 - UJNR Panel on Wind and Seismic Effects Workshop, Dam Task Committee - Dr. Robert Hall, U.S.-Side Chair and U.S. Team Leader
- May 99 - EQEN Field Review Group Meeting, Vicksburg, MS
- 2- 5 Jun 99 - Fifth Benchmark Workshop on Numerical Analysis of Dams, USCOLD, Denver, CO
- 7 - 9 Jun 99 - Dam Safety Investigation Workshop, University of Colorado, Boulder, CO
- 14 - 18 Jun 99 - Seismic Stability of Embankment Dams, PROSPECT Course, Vicksburg, MS - Don Yule and Joe Koester
- 30 Jan - 4 Feb 00 - 12th World Conference on Earthquake Engineering, Auckland, New Zealand
- 3 - 8 Aug 00 - Geo-Denver 2000 Conference, Geo-Institute/ASCE Multidisciplinary Congress, Denver, CO

Coming in Next Issue

- ! Robert Hall's China Experiment**
- ! Don Yule and Ellis Krinitzsky's Visit to USGS**
- ! Mike Sharp Back from RPI Centrifuge**
- ! WES Centrifuge Liquefaction Experiments**
- ! And More**



Recognize these folks?



What we hope to avoid in the future.



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OFFICIAL BUSINESS
